

United States Patent Application for

**BIO-HAZARD ATTACK FAMILY SURVIVAL DOME**

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## BIO-HAZZARD ATTACK FAMILY SURVIVAL DOME

This invention claims the benefit of priority to United States Provisional Patent Applications 60/458,923 filed March 27, 2003; and 60/507,850 filed September 30, 2003.

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### FIELD OF USE

This invention relates to temporary shelters, in particular to an easy and quick to assemble sealable tent enclosure structures having air filters for use as a safe environment from emergency conditions such as those occurring during biohazard and chemical warfare and nuclear fallout emergencies.

### BACKGROUND AND PRIOR ART

In the last several years Americans have been threatened with potential chemical and biological attacks. Airborne toxic agents such as nerve gas, mustard gas, serin, cyanide, etc.) dispersed biohazard aerosol compounds (such as anthrax, smallpox, polio, bacteria, viruses, or fungi), or other atmospheric toxins, are now a real threat to the average citizen.

After the September 11, 2001, disaster, it became popular to purchase plastic sheets and duct tape as a potential safeguard against the dangerous airborne toxins that would come with such attacks. The time frame between the attacks and possible contagion has been estimated to be as low as 15-20 minutes. However, using duct tape and plastic sheets would not offer a quick solution to preventing contagions since using duct tape and plastic sheets could take most of and potentially more than the time it takes for contagions to arrive. Still furthermore, plastic sheeting and duct tapes are used to create a wall, and do little to prevent contaminated air from entering in through leaky windows and doors.

Over the years there have been various types of body suits such as HazMat(hazardous material) suits, and diving suits and the like. However, these suits are difficult and time consuming to wear. In addition, these suits are for protecting single persons and not two or more persons at one time.

5        Various enclosures have been proposed such as bed tents, and the like. See U.S. patents: 4,590,956 and 4,852,598 to Griesenbeck; 5,688,297 to Spengler; and 6,508,850 to Kotliar. However, these enclosures are primarily directed toward protecting a single sleeping person that is in a horizontal position, and would not be useful for creating a livable and useable habitat enclosure. Also, these enclosures would not be able to seal  
10      against and be impervious to chemical and biological airborne agents and radioactive particles(from nuclear fallout) that can occur in a terrorism attack.

A larger enclosure is shown and described in U.S. patent 6,666,910 to Burkhart. However, this enclosure would appear to take potentially longer than the 15-20 minute time limit that would occur with an unexpected act of terrorism. This enclosure seems to  
15      be a modified version of using sheet plastic and duct tape that would not work. Also, the sheet material in Burkhart does not describe, teach, nor suggest how it would be able to seal against and be impervious to chemical and biological airborne agents and radioactive particles(from nuclear fallout) that can occur in a terrorism attack.

Thus, the need exists for solutions to the above problems with the prior art.  
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#### SUMMARY OF THE INVENTION

A primary objective of the present invention is to provide a protective tent enclosure and method of use as a temporary habitat for protection against all airborne biological and chemical toxins and nuclear fallout, that can be quickly deployed within  
25      approximately five minutes.

A secondary objective of the present invention is to provide a protective tent enclosure and method of use as a temporary habitat for protection against airborne

biological and chemical toxins and nuclear fallout, that is self-contained, portable, and inexpensive.

A third objective of the present invention is to provide a protective tent enclosure and method of use as a temporary habitat for protection against airborne biological and  
5 chemical toxins and nuclear fallout, that can keep a family or group isolated and safe.

A fourth objective of the present invention is to provide a protective tent enclosure and method of use as a temporary habitat for protection against airborne biological and chemical toxins and nuclear fallout, that uses a multi-tiered and multi-phase filtration system for providing air to occupants of the enclosure.

10 A sixth objective of the present invention is to provide a protective tent enclosure and method of use as a temporary habitat for protection against airborne biological and chemical toxins and nuclear fallout, that can house anywhere from approximately one to approximately ten people.

Expandable enclosures and methods of assembling enclosures for anywhere from  
15 two to ten or more occupants. Flexible and foldable material such as a multilayer sheet material can be used to form a floor, walls, and roof portion of an enclosure that prevents contaminants from chemical, biological and nuclear accidents and terrorism attacks from entering into the enclosures.

The novel invention can go from a folded compact state to a fully assembled and  
20 occupant ready to be used state in less than approximately five minutes.

Features such as watertight and airtight sealable zipper type fasteners, positive and/or negative pressure causing blower fans, release valves, and the like, can also be used. Negative pressure can be used to filter air coming out of the enclosure.

A multi-stage filtration and blower can also be used for releasing air from the  
25 enclosure for quarantine purposes. A four phase filtration system can include a Nuclear rated HEPA cell, activated Carbon cell, microbial filter and electrostatic filter.

A multistage air filter can be used with the invention which assures that the breathing air inside the tent enclosure can pass certain tests for guaranteeing the personal safety from contaminated toxic or radiation hazard fallout which may be present in the outside air during or following a terrorist attack within our homeland. The uniqueness of 5 this air filtration system lies in the design and functional configuration of a HEPA filter stage, a silver activated granular carbon filter stage, multiple permanent electrostatic grid/foam stages, expanded metal filter stages, microbial filter stages, and in the most sophisticated version, high-voltage plasma/ionic electrostatic filtration with an ultraviolet photochemical purification stage and negative ion dispersion.

10 The functional configuration described has application to both the enclosure controlled environment as well as to whole house indoor air quality control. The latter application would utilize similar components scaled up in size and packaging to fit into a typical household or commercial air handling system.

15 Further objects and advantages of this invention will be apparent from the following detailed description of the presently preferred embodiments which are illustrated schematically in the accompanying drawings.

#### BRIEF DESCRIPTION OF THE FIGURES

20 Fig. 1 shows a collapsed version of the support poles and folded enclosure of the invention that when disassembled can fit into a small carryable box.  
Fig. 2A is a side view of an embodiment using telescoping pole pieces for the enclosure.  
Fig. 2B is a side view of an embodiment using sleeve joined pole pieces for the enclosure.  
Fig. 3 shows an enlarged view of sliding the assembled poles into raised sleeves of the dome shaped material.  
25 Fig. 4 shows an assembled tent enclosure with the two cross configured poles supporting an expanded dome shaped enclosure configuration.

Fig. 5 is an enlarged view of the four stage multi-filter system that can be used with the preceding embodiment.

Fig. 6 is another embodiment of the enclosure.

Fig. 7 shows equipment that can be used inside of the enclosure invention.

- 5 Fig. 8 is an exploded view of another embodiment of a multi-stage filter system that can be used with the invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before explaining the disclosed embodiments of the present invention in detail it  
10 is to be understood that the invention is not limited in its applications to the details of the particular arrangements shown since the invention is capable of other embodiments.

Also, the terminology used herein is for the purpose of description and not of limitation.

Fig. 1 shows a collapsed version 1 of the two main support poles 10, 15 and folded enclosure 100 of the invention that when disassembled can fit into a small  
15 carryable box 20 that can have a size of approximately twenty seven inches by approximately twenty nine inches by approximately ten inches, and an overall weight of less than approximately forty five pounds. The preferred embodiment can use two poles that are formed by interconnecting separate smaller pole pieces together, which is described in reference to Figures 2A-2B.

20 The individual pole pieces can each be formed from tubular metal, spring steel, plastic, graphite, fiberglass, composite, and the like, similar to pole supports used in existing tents such as those manufactured by Coleman® and the like. For example, the invention can use similar bendable poles such as those shown and described in U.S. patents 4,590,956 which is incorporated by reference. The invention uses pole pieces that  
25 when assembled can create a rod shape that can flex but with a memory that tends to force the rod back into a straight rod configuration.

Fig. 2A is a side view of an embodiment using telescoping pole pieces 10A for the enclosure. Here, a single pole can be assembled from four hollow cylindrical pole pieces 10A each having a narrow tip end 12A which telescoping is interconnected into a rear end of the next pole piece 10A as shown by arrows X.

5 Fig. 2B is a side view of an embodiment using sleeve joined pole pieces 10B for the enclosure. Similar to the preceding figure, four separate cylindrical pole pieces 10B can be joined end to end with one another by sleeves 12B which are only slightly larger in diameter than the pole pieces 10B.

As shown in Fig. 1, the enclosure 100 itself can be taken from a storage container  
10 20 in a folded state. The enclosure 100 can have the unfolded shape of a dome type shape with walls and floor portion. The enclosure 100 can be formed by attaching separate multi-layers of sheet material together so that edges are sealed against one another preferably by RF(radio frequency) welding techniques and the like.

The multi-layered material used for enclosure 100 can be transparent and  
15 transparent to light in addition to being impervious against chemical and biological airborne agents.

Additionally, the multi-layered material used for enclosure 100 can be colored and/or dyed so as to be opaque to light while still being impervious against chemical and biological airborne agents.

20 The multi-layered sheet material used for forming the enclosure must be flexible and foldable, and impervious to biological and chemical agents, such as the multi-layered material labeled as Challenger X-22 and X-23, which is shown and described in U.S. Patent 6,652,943 to Tukaschinsky et al., assigned to Saint-Gobain, which is incorporated by reference. A preferred embodiment of the subject invention can use a multi-layered  
25 material such as the Tukaschinsky patent that has a thermoplastic polymer layer in contract with a crosslinkable polymer layer to form an intercrosslinked multilayer polymer sheet material. The thermoplastic layer can include a thermo plastic polymer

layer of a thermoplastic resin comprising polyolefins, polyamides, polyesters or fluoropolymer resins, and/or include a crosslinkable polymer such as polyamides, polyesters and their copolymers, and polyolefins including polyethylene.

The sheet material can be formed from multi-laminates, and include substances  
5 such as Teflon®, and the like, as well as other materials that would be impervious to  
chemical and biological gases and particulates as well as radioactive gases and  
particulates, and the like.

Table 1 provides a list of Biological and Chemical Contagions and Nuclear  
fallout in gas and/or various particulate form that can be prevented from passing into the  
10 novel enclosure.

Chemical Agents	Biological Agents	Nuclear fallout
nerve gas	anthrax	radioactive
mustard gas	smallpox	particles( $\geq 0.3$ micron)
serin	polio	
cyanide	bacteria	
Hydrogen Sulfide	viruses	
Sulfur Dioxide	fungi	
20 Nitrogen Dioxide.	SARS(Sudden Acute Respiratory Syndrome	
ricin		

The novel multi-layer sheet material used in the subject invention enclosure 100  
can be sized to have a thickness of approximately 4 to approximately 12 mils  
thick(preferably approximately 6 to approximately 8 mils thick), and be impervious to  
25 various biological and chemical airborne agents. The agents can be in the form of gases  
and particulates.

When taken from a storage container 10 as shown in Fig. 1, the folded enclosure  
100 is unfolded, and is raised into a dome configuration by placing two assembled poles  
(10', 15') each through raised sleeves 112 that are preformed by stitching and the like, on  
30 side wall panels 110 of the enclosure 100 as shown by the pole 10 being inserted in the  
direction of arrow S into raised sleeves 112 on enclosure wall 110 shown in Fig. 3. A

single person can fish a single long pole 10' into the raised sleeves 112. The pre-existing dome configuration shape forces the poles 10', 15' to flex which together creates the assembled dome configuration 100'. End tips 11 and 16 on each of the poles 10', 15' can extend downward beneath the floor portion 120 of the assembled enclosure 100'.

5 Fig. 4 shows an assembled tent enclosure with the two cross configured poles 10', 15' supporting an expanded dome shaped enclosure configuration 100'. The dome configuration 100' with floor portion 120 when assembled with support rods 10' and 15' can measure approximately six feet by approximately nine feet wide by approximately seven feet high. Other versions of the dome shape can include approximately nine by 10 approximately nine feet by approximately seven feet high. Another version can be approximately ten feet by approximately 18 feet wide, and approximately seven feet high.

The preferred embodiment of the assembled enclosure 100' can include a zipper arrangement 150 along one outer wall. The zipper 150 is preferably an air tight and watertight fastener such as those used by divers and with body bags, and can be of multi-layer configuration and be similarly formed with the multi-layer material previously described. The zipper 150 can be attached to the enclosure walls by the RF welding technique previously described and/or by being sewn, and the like, thereon. Examples of such zippers can include but are not limited to those shown and described in reference to U.S. Patents: 4,099,656 to Neumann et al. and 4,641,400 to Morelan, each incorporated by reference. Alternatively, the invention can use other types of watertight and air tight fasteners that can include multi-layer hook and loop fasteners, snap fasteners and the like, that must also be able to seal a positive air pressure inside of the enclosure.

Fig. 5 is an enlarged view of the four stage multi-filter system 200 that can be used with the preceding embodiment. Referring to Figures 4 and 5, the enclosure 100' can have an external blower 205 such as an electrically operated fan motor that can blow up to approximately 105 cubic feet of air or more into the interior of the enclosure 100' through a multi-stage filtering system 210/220/230/240. The multi-stage air filters can

clean contaminated air outside of the enclosure to create a clean air supply for occupants inside of the enclosure.

The multi-stages can include a carbon filter, a HEPA filter, an anti-microbial filter and an electric filter. The carbon filter can be a carbon-filter-nuclear rated activated  
5 carbon bed cell which can absorb virtually all gases and odors that pass through.

Adsorption in the process by which activated carbon captures gases and odors, such as ones used for military gas masks, and the like. The HEPA(High Efficiency Particulate Arrestance) filter can be rated to capture approximately 99.99% of radioactive particles as small as approximately 0.3 microns from entering into the enclosure. The anti-microbial  
10 filter captures and kills airborne microbes by using a UV(ultraviolet light) source in various selected nanometer ranges for killing off microbes, and the like. The electric filter can be an electrostatic filter, a high voltage filter, and/or an electret type filter, such as the one shown and described in reference to U.S. Patent 4,185,972 to Nitta et al, which is incorporated by reference. The various filters can be connected together so that  
15 external air is purified by being passed through each filter stage.

The blower motor 205 can also be used for providing a positive pressure inside the tent when it is occupied, which also helps keep undesirable chemical, biological and radioactive agents, particulates, and gases from entering into the enclosure.

A multi-stage filtration and blower can also be used for releasing air from the  
20 enclosure for quarantine purposes. A second filter system with blower can be used for forming a negative pressure to filter air coming out of the enclosure.

A release valve 300 Fig. 4 can be used to release excess pressure inside of the enclosure 100', and can release at selected pressure ranges such as but not limited to approximately one pound per square inch, and the like.

25 In addition, the invention can also use the blower to make the tent enclosure self inflating, to that the pole supports do not always have to be used to expand the enclosure into a working assembled state.

Fig. 6 is another embodiment of the enclosure 400. An extra rectangular portal entrance 410 can be used to create more interior room inside of the enclosure 400. Additionally, the enclosure 400 can be provided with windows 420 formed from similar material to that previously described so that part of the external walls of the enclosure can 5 be opaque, and/or colored and the like, while the windows 420 allow for translucent and transparent portions for the enclosure 400. The invention can also substitute single stage air filtering instead of multi-stage. For example, air filter canisters 250 such as those used with hazardous material suits, and the like, can instead be connected to the blower 205 previously described to pass air into the enclosure 400. Extra lines 260 such as cable 10 connections for power, telephone, and the like, can be used to supply power from various power sources, such as but not limited to 120 volt, rechargeable battery supplies and solar sources to provide power to equipment 500 inside of the enclosure.

Fig. 7 shows equipment 500 that can be used inside of the enclosure invention. The equipment 500 can include but is not limited to 12 volt chargers 510, heavy duty 15 safety clamps 520, AM/FM radios 120 volt DC outlet, LED battery status indicator, and a 250 psi 12 volt air compressor 540 can be used.

The subject invention tent enclosures were tested in environments where various noxious gases were present outside of the novel tent enclosures, and readings were taken inside a closed tent enclosure of the invention. Table 2 compares OSHA(Occupational 20 Safety and Health Act) PEL standards for the amount of exposure level that is considered acceptable for various noxious gases such as Hydrogen Sulfide, Sulfur Dioxide and Nitrogen Dioxide.

Table 2. Test Results

Noxious Gas	OSHA PEL (PPM)	Ave. Exposure Level (PPM)	Ave. Level BIODOME (PPM)
Hydrogen Sulfide	20	25.795	1.964
Sulfur Dioxide	5	5.085	0.293
Nitrogen Dioxide	5	5.422	0.771

PEL refers to Permissible Exposure Level, and PPM refers to part per million.

From Table 2, it is clear that the invention tent enclosure surpasses OSHA  
10 standards for Noxious Gases and Particulate Elimination.

Following these tests, the invention tent enclosures were subjected to over four(4) times the OSHA PEL(permissible exposure level limits) for Nitrogen Dioxide, while the concentration level inside the novel tent enclosure was verified to remain below the OSHA PEL level listed in Table 1. For these tests the novel tent enclosure was subjected  
15 to noxious gases for a twenty four(24) hour duration.

The novel enclosures can allow for a comfortable level of freedom of movement and activity such as reading, watching TV or listening to the radio, playing with cards or other small group games, etc. The invention can provide a level of protection comparable  
20 to donning hazmat crew suits but without the physical (and mental) encumbrances.

For outdoor use, and additional silvered covering draped over the clear plastic sealed enclosure (like aluminum foil) could provide solar thermal and similar radiation protection. In colder climates, lightweight thermal blankets (aluminum foil clad cloth) may also be appropriate.

25 When being ready for use, the inventors recommend that users of the enclosures have an adequate supply of fresh, bottled water be supplied inside the dome enclosure shelter (approximately 3 liters per person per day), nutritional snacks, a porta-potty, an

inflatable bed, an inflatable floor covering, inflatable chairs, and a host of battery powered appliances such as a multi-band radio, small TV, portable audio recorder, laptop computer if available, a 9-watt fluorescent lamp, an air circulating fan, an air compressor, and a cellular phone. A manual billows pump would be handy in order to assure an

- 5      adequate supply of fresh air drawn in through the filter/masks units. The use of a small air purifier with room air ion production, ultra-violet radiation, and ozone generation would be most effective.

Other items can include but are not limited to a first aid kit, small fire extinguisher, necessary medications, braces, bandages, dental care kit, and a hunting knife  
10     (and perhaps a self-defense weapon), compass, watch, notepad, pencils or pens, book or magazines. A fully-charged 12-volt automotive booster battery (perhaps with a solid-state inverter) would operate appliances for many hours, even blenders or massagers. Inflatable furniture would store compactly and provide comfort for occupants sitting or sleeping.

The novel invention can be used as an isolation chamber designed for temporary emergency habitation during, for example, a chemical warfare attack of several hours duration, its family and friends occupants will be protected from the most serious harmful and life-threatening effects.

The invention allows for a low cost, affordable by a majority of families, this form of protection can be made available, with various options providing for an additional  
20     level of comfort.

The novel enclosure is a novel family protective shelter which can be erected quickly inside a home living room, family room, patio, or on an outside lawn area. This dome tent enclosure is designed of clear plastic sheet material which is impervious to gasses used to conduct chemical warfare (such as anthrax, smallpox, polio, bacteria,  
25     viruses, or fungi, or other atmospheric toxins. This protective "pop-up", external frame enclosure will be size to house two to six adults comfortably (6' x 9' x 7' high inside, up to about 10' x 18' x 7' high) can incorporate a zip-lock entrance/egress isolation portal

chamber, and will communicate to the outside world through combat gas mask filters, plus phone, computer and electrical outlet feed-through, and perhaps a water trap coupling. The object is to keep a family of 1 to 10 (with a larger size) relatively isolated and safe from the harmful effects of a chemical biohazard, or nuclear fallout enemy attack 5 for a matter of hours up to several days. The portal chamber can be used to also connect together additional dome tent modules to accommodate more family members.

Fig. 8 is another version of a multi-stage filter system 600 that can be used with the invention. The invention can use a composite filter system with a pop-up doomed tent structure of gas impervious plastic which can be erected in about two minutes by two 10 people and serves as a sealed controlled environmental chamber for temporary living quarters, thus avoiding contamination, and subsequent risk from disease or death, from the outside world.

The battery-powered blower assembly 605 with inlet air port screen 602 powered by , a sealed-motor boat engine compartment squirrel-cage exhaust fan, can be inserted at 15 this housing portion 607. Next follows a multi-layer expanded metal screen filter 610, a polyurethane open-cell foam filter 615, a permanent electric electrostatic grid filter 620, a separating urethane foam filter 625, a matching electrostatic grid 630, a foam filter separator 640, a silver activated granulated charcoal filter assembly 645, an additional expanded metal screen 650, to keep the charcoal filter compacted, a microbial treated 20 pleated fiber filter 660, and finally a certified HEPA filter 670 can be used to complete the composite filter assembly. A three-inch or greater plastic duct 680, 685 then directs the air flow into the environmental enclosure 100', 400 previously shown and described.

It is also possible to position the blower motor-fan assembly at this end, which would allow the air to be drawn through the filter composite and forced into the tent, as 25 opposed to forcing the air under pressure through the whole modular filter system. Note also that this total configuration is designed to be placed outside the enclosure and also protects against the effects of rain.

The feed-through plate 690 at the lower left of Fig. 8 allows not only sealed air passage but also sealed electrical and telephone connections. A manual billows pump can also be supplied with this system in event of total electrical (battery plus line) failure. A Peltier or other small air conditioning cooling or heating module can also be added on 5 either end of the filter coupling system for added comfort.

The whole-house unit can also incorporate the additional features of a high-voltage electrostatic stage, an ultraviolet exposure lamp, a small amount of ozone generation, as well as a negative ion generator at the exit end in order to ensure total molecular disintegration of all chemical and bio-hazardous substances and provide a 10 positive mood enhancement. An Oxygen concentration monitor is also recommended, along with alarm detectors for excess Carbon Monoxide, Carbon Dioxide, and other important constituents.

Although a dome configuration is shown, the invention can include other shapes, 15 such as but not limited to rectangular, square, hexagon, triangular, and the like.

The invention can have utility in various applications ranging from military and public safety to health care, and the like. In addition to family and personal safety the invention can be used for medical isolation, burn victims, and anywhere that clean air isolation is needed.

20 For example, the invention can be used for housing SARS (Severe Acute Respiratory Syndrome) patients, and anyone that has been exposed to any contagious elements.

Additionally, the invention can be used downwind of natural disasters such as near forest fires, and the like. Carbon noxious fumes can be prevented from entering and 25 affecting occupants inside of the novel tent enclosure.

The novel tent enclosure invention can be sized for two men, five men, six men, and ten men occupants, as well as for other numbers of occupants.

The novel invention can be used to clean breathing air to protect personnel subject to terrorist or accidental chemical, biological nuclear fallout, smoke, allergenic agents, or other hazardous atmospheric pollutants.

A household version could aid many people who suffer respiratory problems or  
5 who suffer from contagious diseases, or who require isolation from the normal environment or who require a controlled environment for any reason.

Since we as a nation, have already suffered from enemy terrorist attacks on our own soil on 9/11/01 in New York City and in Washington, DC, we realize the hard fact that we are vulnerable to future unwanted threats on our lives. It is the family unit that  
10 has built this nation and has given the United States its strength... and must be protected. Planning for survival in biohazard and chemical warfare emergencies makes sense in view of the many instances around the world where such attacks have led to suffering and casualties. Even now, we are at war in foreign combat zones, where "at home" retaliation is threatened by demented suicide bombers and murderers. Field combat troops in small  
15 units also need this type of protection with portability, quick set-up and air filtration against gas-attacks.

With a properly constructed isolation chamber designed for temporary emergency habitation during, for example, a chemical warfare attack of several hours duration, its family and friends occupants will be protected from the most serious harmful and life-threatening effects by breathing filtered and purified air using the blower and multi-stage  
20 filtration system described in this document.

The invention allows for a low cost, affordable by a majority of families, this form of protection can be made available with various options providing for an additional level of comfort. Not only is this system applicable with the protective enclosure, but this aid  
25 filtration system can easily be scaled up in size, utilizing the same types of multi-stage components to protect the inhabitants and contents of an entire household, provided that air leakage and circulation paths are identified and controlled.

While the invention has been described, disclosed, illustrated and shown in various terms of certain embodiments or modifications which it has presumed in practice, the scope of the invention is not intended to be, nor should it be deemed to be, limited  
5 thereby and such other modifications or embodiments as may be suggested by the teachings herein are particularly reserved especially as they fall within the breadth and scope of the claims here appended.